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Spruce budworm
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BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

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SPRUCE BUDWORM REPORT
1949

By

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Fort Collins, Colorado

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SPRUCE BUDWORM REPORT 1949

In 1949 it was decided to make budworm collections in the vicinity of Union, Oregon with the primary object of obtaining the Larvaevorid parasite, Ceromasia auricaudata, and the Ichneumonid, Phytodietus fumiferanae, for liberation in Maine. Union, Oregon was selected for the work because Mr. Charlie Speers of the New Haven, Connecticut laboratory found a high percent of parasitism by C. auricaudata in collections he made in the Catherine Creek drainage in 1948. It was hoped that parasitism would persist at a high level and that a good number of these parasites could be obtained.

Laboratory space was kindly provided at the Union District Ranger Station and every cooperation was given by the Ranger and his staff. Labor for collecting and sorting the material was obtained from Union.

The writer arrived at Union, June 4, but due to budworm development being later in that area than was expected, mass collecting was not started until June 27. A total of 114 man days were used to collect and sort an estimated 89,132 specimens. Three methods of collecting were used. The first was to snip infested tips from the host tree and drop them into collecting cans prepared for budworm work. The second was to place a muslin sheet under an infested tree and bat the branches above it with long sticks. Larvae and pupae that fell on the sheet were picked up and placed in cans. The third method was the same as above except that the larvae and pupae together with the debris that fell on the sheet were all dumped into the collecting cans. This method was somewhat faster than the others for the collectors, but very much slower for the sorters at the laboratory and was discontinued after 3 days use. When a collector filled the 5 gallon can he was carrying, the material was placed in a cotton feed bag and tied securely so that no specimen could escape. Whenever it was possible the material collected in the morning was taken to the laboratory at noon, and the afternoon collection was brought in after the days work was over. With the exception of a snow storm on June 29, there were no delays from unfavorable weather.

Table 1 shows the number and species of parasites reared from the mass budworm collections. It will be noted that parasitism is low for the total average, and was not high in any of the collections. There seems to be relatively little difference in parasitism whether the budworm was taken from severely defoliated trees or from those with a lighter infestation. Hymenoptera parasites that emerge from the larvae were far more abundant than forms that came from the pupae. This has been characteristic of the collection made in other areas in the past.

Table 2 shows the number and species of parasites that emerged from special budworm collections made prior to the mass operations with the exception of the one made June 30. It is interesting to note that the percent of parasitism by Ceromasia auricaudata was considerably higher in the material taken June 30 than it was in the other collections. The budworm larvae in this collection were taken from a few small Douglas-fir that could be found with very much less defoliation than occurred on adjacent trees. Data on parasitism in specimens taken from adjacent trees is shown in the collection made June 22. The second highest percent of parasitism by C. auricaudata was obtained from the material collected June 10. This collection was from white fir with relatively little damage prior to and during 1949. The June 30 collection was made from trees only a few chains from those where Speers made his collection in 1948 and the June 22 collection was about 3/4 mile away. The collections made at Dale and Battle Mountain State Park were from the same areas where Speers made his collections in 1948.

The budworm population in all the areas visited is not uniform. In most cases there are centers where the budworm population has been building up over a period of years. In many of these centers the 1949 foliage is completely destroyed and the larvae moved back and fed upon needles produced in previous years. These defoliated areas in some cases are only a mile or so across with very little injury beyond, even though the host type and site is more or less continuous. In some cases these "hot spots" are coalescing at the present time, but obviously they were separated for some time in the past. Millions of larvae dropped to the ground after all the 1949 foliage was consumed. Many of these larvae were seen to be caught by ants, but a good many crawled back into the same or adjacent trees. Stumps in these hot areas were usually covered with webs that hundreds of larvae made when they crawled up on them and could not go higher. This condition was not observed on the margins of the centers where there was sufficient food for the larvae.

On June 9, an effort was made to get some index of the budworm population in the hot centers and also in their marginal areas. This was done by counting the larvae on each of 10 branches, 15 inches in length taken from various parts of 10 trees in both areas. On June 27, samples were again taken from these same trees. Table 3 presents the data obtained. It will be noted that there was a very high population on June 9 in the center area and even though the reduction by June 27 was tremendous it was still higher than it was at the margin. On the latter date all of the 1949 foliage had been destroyed in the center, and the larvae were feeding upon foliage from previous years growth. The two sampled in the center were approximately 1/2 mile from those sampled at the margin, and are believed to be more or less comparable of other trees in those areas.

An effort was made to obtain data to determine whether the fly eggs observed on budworm larvae were laid by one species of parasite, and whether a particular segment of the host was selected if more than one species was involved. All of the larvae that were observed to have eggs on them were isolated in vials and fed fresh foliage as it was needed. A total of 82 larvae were so treated and from these 43 yielded Omatoma fumiferana; 1 Zenillia caesar; 1 Ceromasia auricaudata, and 1 undetermined larvaevorid; 13 larvae died; 11 moths emerged; 4 pupae had parasites emerge and escape so their identity could not be determined; 4 specimens died as pre-pupae. There was no uniformity as to the position of

the parasite egg on the host larvae that later yielded Cnatoma fumiferanae. The eggs were distributed all the way from segment 1 to 8. In some cases they were right of dorsal and others left as well as dorsal, and eggs were often placed between segments. The central segments 3 - 5 had the majority of eggs upon them. This seems to indicate that O. fumiferanae does not select a particular segment of the host for oviposition. Ceromasia auricaudata is known to deposit its eggs upon the foliage, and not upon the host larvae so the one specimen that emerged apparently was able to dominate over a species that oviposited upon this larvae. Whether this is general in nature is unknown. The Zenillia caesar emerged from a larva that had 3 eggs upon it. One other larva had 4 eggs, but it died without yielding any parasites. All of the other larvae had only 1 egg each upon them. An examination of the pupal cases from which the parasites emerged showed that with 6 exceptions all of the parasites emerged between the thorax and first abdominal segment. The moths developed from larvae that had eggs on various segments, but in general they were comparable to those from which parasites emerged.

On June 13, sixty four representative larvae from trees with complete destruction of the 1949 foliage were isolated in 8 dram vials, and 50 other larvae from white fir with plenty of 1949 foliage were also isolated. This was done to determine whether parasitism was different in larvae from these sources. It is interesting that from the severely defoliated trees Glypta fumiferanae emerged from 18 of the 64 larvae; Apanteles fumiferanae from 7; undetermined Hymenoptera from 2; 5 died in the pupal stage and 32 yielded normal moths. These moths were placed in alcohol with the object of dissecting the females to get data on the number of eggs present in them to compare their fecundity with moths that developed on trees with an abundance of 1949 foliage. The 50 larvae from white fir with plenty of 1949 foliage yielded 1 O. fumiferanae; 2 A. fumiferanae; 1 Phytodietus fumiferanae, 1 Actia and 1 Ceromasia; 2 larvae died, 1 pupa died, and moths emerged from 38. These moths as mentioned above, were placed in alcohol to compare their fecundity with the moths from defoliated trees.

A collection of 125 budworm larvae from small lodgepole pine in an area of the Catherine Creek drainage with complete destruction of the 1949 foliage yielded 15 Glypta, and 2 Apanteles but nothing else.

Sawfly larvae were more or less common on white fir along with budworm larvae. A number of these were isolated, but no parasites emerged from the larvae. The pupae were turned over to Mr. Furniss at Portland, because it would be unwise to ship this insect east and run the risk of it getting away. The object in working with the sawfly larvae and pupae was to see whether they might act as alternate hosts for some of the budworm parasites. Fly eggs were observed upon a very few sawfly larvae. In view of the fact that C. auricaudata oviposits on the foliage it would seem that sawfly, and budworm larvae would have about an equal chance of ingesting some of the eggs. Whether the eggs of this parasite are destroyed or develop in the sawfly is not known, but perhaps some light will be thrown on this matter from the sawfly pupae that were turned over to Mr. Furniss. However, Ceromasia for example, is almost as large as the sawfly, consequently, it seems improbable that this parasite could reach normal size in these sawfly pupae.

The persistence of very high budworm populations in areas where Speers found high parasitism in 1948, raises some disturbing questions. It would seem that if the high degree of parasitism he found were representative of the Catherine Creek area, for example, that the budworm population this year should have been far lower than it was, otherwise one is inclined to wonder whether parasites are of as much importance in supressing budworm populations as some of us have been considering them to be. In any event there is a need for much more information on the degree of parasitism necessary to hold a budworm population at an endemic level, and to reduce an epidemic to an endemic status if entomophagous insects are a major factor in these changes. Much information is needed about the secondary hosts needed for those parasites that have them. It is quite evident that the population of Coromasia for example, is very much influenced by the abundance of secondary hosts, because this parasite must go over the winter in some other insect. It seems that techniques could be developed to rear many if not all of the budworm parasites under laboratory or controlled conditions. Attempts to obtain various budworm parasites has demonstrated the uncertainties involved in this work. There is need for a great deal of concentrated study on the budworm in the western states. At the present time there are high budworm populations persisting in New Mexico, a population on the Pike National Forest in Colorado seems to be increasing, and in the north west it is hard to predict what the end will be in the fir stands, but it is serious to say the least.

Submitted by,

W. D. Buchanan
Entomologist

cc: Craighead
Brown
Dowden
Furniss
Circulate other stations

Included Horogenes sp., and secondary parasites of Aphanteles, Glypta, Horogenes

included Phryxe pecosensis T.T. Phorocera erecta Coq. VMC

Table 1 - Budworm parasites reared from mass budworm collections taken from White fir and Douglas-fir in the Catherine Creek drainage near Union, Oregon 1949

Date Collected	Number Larvae & Pupae 1/	Parasites from Larvae: Glypta fumiferanae	Apanteles fumiferanae	Phytodietus fumiferanae	Misc. Hymenoptera	Ceromasia auricaud	Parasites from Pupae: Actia ata	Madremyia saundersii	Omatoma fumiferanae	Zenillia caesar	Miscellaneous Diptera	Miscellaneous Hymen.	Total Number Parasites	Percent Parasitism
June 27 3/	4,000	134 3.3%	15	41	6	46		46	55	5	3	3	354	8.85
" 28 3/	5,000	148 3.0%	68	29	12	85		10	147	5	0	6	510	10.20
" 30 4/	7,000	595 8.5%	193	15	90	271		141	203	15	2	9	1,534	21.91
July 1 4/	10,000	790 7.9%	541	9	255	111		156	185	48	1	8	2,275	22.75
" 2 5/	10,000	434 4.3%	153	4	202	26		18	78	8	2	3	928	9.28
" 5 5/	18,300	1,026 5.6%	702	8	425	60		33	296	53	3	2	2,608	14.25
" 6 5/	6,866 6,166	358 5.2% 348 5	249	6	176	314		26	88	7	5	2	1,231	17.93
" 7 5/	7,000	67	11	4	0	148		9	125	13	1	0	378	5.40
" 8 5/	8,000	70	17	1	0	25		24	200	7	2	0	346	4.23
" 8 3/	5,772	75	24	2	6	61		3	225	6	0	0	402	6.96
" 11 3/	7,194	64	33	2	0	22		5	14	1	0	0	141	1.96
TOTAL	89,132	3,941	2,006	112	1,172	1,169		471	1616	168	19	33	10,707	11.25 Ave.

1/ Number of specimens collected was estimated on the basis of the actual number obtained during the half hour periods from 10:00-10:30 a.m. and 3:00-3:30 p.m.

2/ A few Madremyia emerged from the larvae as did some Actia which are included in Miscellaneous diptera.

3/ Collections made on these dates were from trees, with very little damage prior to 1949 and in 1949 the budworm population did not consume nearly all of the current years foliage.

4/ Collections made on these dates are from trees with budworm population so high that all of the 1949 foliage was consumed and the surviving larvae fed extensively upon old needles.

5/ Collections made on these dates are from trees between 3 and 4 above. The budworm population was not so high as in 4 and higher than 3.

89,132 Total No. SBW
− 5,947 Killed by Apant. & Glypt
83,185 Corrected No. Full grown SBW

Ceromasia 1.4%
Madremyia 0.6%
Omatoma 1.9%

Table 2 - Budworm parasites reared from special budworm collections taken in the areas indicated

Date Collected	Number Larvae & Pupae	Parasites from Larvae: Glypta fumiferanae	Apanteles fumiferanae	Phytodietus fumiferanae	Misc. Hymenoptera	Ceromasia auricaudata	Parasites from Pupae: Madremyia saundersii	Exatoma fumiferanae	Zenillia caesar	Miscellaneous Diptera	Miscellaneous Hymen.	Total Number Parasites	Percent Parasitism
June 10	2,000 1/	33	3	1		86						123	6.15
" 17	300 1/	13	1	1	3	1	1	2	1	1	3	27	9.0
" 17	300 2/	23	1			5		1		2		32	10.66
" 20	500 2/	40	4			2	4	3		3		56	11.20
" 20	500 1/ 3600	5 114 3.2%	8	7	6	14		4		1		45	9.00
DALE " 21	✓ 800 3/	71	7	1	2	0.6% 11 { 8	12 } 31 1.7%	6				107	13.37
BATTLE MTN. " 21	✓ 1,000 4/	28	7		4	3	19 }		5			66	6.60
" 21	✓ { 500 5/	17	3	13		1	4	0	0			38	7.60
" 21	300 5/ 800	1 (18)	2 (5)	5 (18)	4 (4)	(2) 1	0 (4)	1 (1)	0			14	4.66
" 22	1,000 6/	65	3	1	10	10	11	7	10	2		119	11.90
" 23	600 1/	33	5	9	2	11	2	12		1		75	12.50
" 30	300 7/	4				28	4	4					13.33
TOTAL	8,100	333	44	38	31	170	57	40	16	10	3	742	9.66 Ave.

1/ Taken from white fir with light damage prior to 1949 in Catherine Creek - near Union, Oregon.

2/ Taken from white fir with severe damage prior to 1949 and in 1949 - Catherine Creek near Union, Oregon.

3/ Taken from Douglas-fir with heavy infestation for past few years - collected on sheet at Dale, Oregon.

4/ Taken from white fir with heavy infestation for past few years - collected on sheet at Battle Mtn. State Park, near Ukiah, Oregon.

5/ Taken from Engelmann spruce with moderate infestation - infested tips cut off - taken near Starkey, Oregon.

6/ Taken from white fir with severe defoliation - collected from sheets - Catherine Creek - adjacent to trees felled in 1948 by Charlie Speers of New Haven, Conn. laboratory.

7/ Taken from Douglas-fir with severe defoliation on adjacent trees but much less on the particular trees sampled.

Table 3 - Budworm populations found on each of 10 trees sampled by taking 10 branches, 15 inches in length from each tree on June 9 and 27. The first group of 10 trees are from a "hot spot" with complete destruction of the 1949 foliage and the second group from the margin, some 1/2 mile distant where there was an abundance of 1949 foliage.

Severely Injured Trees				Lightly Injured Trees			
Tree No.	Larvae present June 9	Larvae present June 27	Percent Reduction	Tree No.	Larvae present June 9	Larvae present June 27	Percent Reduction
1	118	6	94.91	1	43	16 ≠ 1 p.	60.46
2	143	25 ≠ 1 p.*	81.82	2	39	8	79.49
3	269	43 ≠ 2 p.	83.27	3	60	18	70.00
4	262	45 ≠ 6 p.	80.53	4	82	21 ≠ 1 p.	73.17
5	143	73 ≠ 2 p.	47.55	5	60	13	78.33
6	204	23 ≠ 1 p.	88.23	6	65	18 ≠ 1 p.	70.77
7	225	21 ≠ 1 p.	90.22	7	65	16	75.38
8	214	26	87.85	8	65	15	76.92
9	215	41	80.93	9	57	17	70.17
10	204	31	84.80	10	37	11 ≠ 5 p.	56.76
TOTALS	1997	347	82.01		573	161	71.14

* Pupae

Table 1. WD Buchanan

Corrected Totals for Figuring Parasitism by Parasites of Full-grown Larvae

PARASITES OF SMALL LARVAE

Glypta	3,941
Apanteles	2,006
Misc. Hymenoptera	1,172
TOTAL	7,119

Catherine Creek – Coll. 6-27 to 7-11-49

TOTAL LARVAE AND PUPAE	89,132
PARASITES OF SMALL LARVAE	7,119
TOTAL CORRECTED NUMBER	82,013

Table 2. Buchanan

	Dale, Ore. 31	Battle Mt. 41	Shirley 51 51
Glypta	71	28	18
Apant.	7	7	5
Misc.	2	4	4
	80	39	27
Total	800	1,000	800
	80	39	27
Corr. Total	720	961	773

Totals for Figuring Parasitism by Parasites of Small Larvae

Glypta – use 6-27 to 7-6, Table 1, and 6-10 to 20 Table 2